Political economy of energy subsidies for groundwater irrigation in Mendoza, Argentina

Sebastian Riera (Georg-August-Universität Göttingen)

Natural resources' policies in Latin America are rarely identified as long-term consistent and power independent. Depending on the time-frame, the province of Mendoza achieves both characteristics. Except on groundwater management were flaws are visible on ensuring quality and availability. Energy subsidies for agricultural irrigation have relied too long as permanent policy suffering political maneuvers every time their stability is under risk. Following a tripod framework to review the institutional settings of the water-energy nexus. Although, the majority of policy tools were demand oriented during the last 15 years; they have not provided consistent economic incentives for agriculture producers to consider environmental degradation of groundwater resources.

A. Introduction

In the area of agriculture and resource economics, challenges for optimization are continuously updated. Facing an increasing demand to provide food with limited resources, imply a more efficient production under changing environmental conditions (FAO, 2013). The reinvigorated interest on the water-food-energy nexus increases public concern for a responsible and efficient use of natural resources (Allan, Keulertz, & Woertz, 2015).

In the arid province of Mendoza, groundwater irrigation is vital for agricultural activities in certain areas. Political will to improve profitability of small producers has distorted economic incentives and led to the creation of power asymmetries among stakeholders and decision makers. Jointly, a political and economic analysis are carried below to unmask the reform arena of public policies that link water and energy in the agricultural sector.

Local governments shall design solid policies that contribute to the responsible use of natural resources and, at the same time, empathize the public preferences. Institutional settings, lack of information, policy implementation time-frames, and political influence may obstruct the optimizing path of social welfare, providing wrong signals to stakeholders (Dinar, 2000; Shah, Giordano, & Mukherji, 2012).

When it comes to water demand, the institutional settings are fundamental to empower stakeholders and set economic incentives. As a multi-purpose resource, water is demanded as a production input or consumption good. Globally, the agricultural sector employs near 70 per cent of the total water supply (Dagnino & Ward, 2012). Groundwater use for agriculture is desirable due to the ability to face production challenges or scarcity periods. Overexploitation and poor management may lead to irreversible quality degradation (Garduño & Foster, 2010).

Jointly, energy and water policies determine institutional settings and power spaces of the stakeholders (Azpiazu, Bonofiglio, & Nahón, 2014). Abuse of economic tools to

maintain political power could jeopardize sustainability of the resource sharping incentives of water users (Badiani, Jessoe, & Plant, 2012).
This paper seeks to describe the economic incentives and behavior of local stakeholders towards the exploitation of groundwater resources. The analysis will focus on the economic and political framework of water-energy nexus.
Main research questions to address are:

1. Are the water and energy policies misguiding the agricultural irrigation system so that quality and long-term availability of the resource are under environmental threat?
2. Under the current political and economic set-up, what are the incentives of local stakeholders to consider the environmental linkages of groundwater use and production?

The main hypothesis is that energy subsidies for agriculture irrigation drive farmers' behavior towards an over-exploitation of the aquifer.

1. Study area

The province of Mendoza is located in a semi-arid region in the central-west of Argentina. It covers an area of 150,839 km^2. It is characterized by its mountainous area, formed by the Andes mountain range that runs from north to south. Rainfall average 220 mm per year. It has a desert-dry, continental climate characterized by the level of summer rainfall regime (Morello, et al., 2012).
During 2013, the provincial GDP reached USD 2.08 billion. The main economic sectors are commerce, services, and manufactures industry, which jointly represent 60 per cent of the province GDP (DEIE, 2014). Agriculture activity contributes with USD 132 million to the regional GDP, representing 7 per cent of the total (DEIE, 2011). The irrigation system reaches 267,889 ha, which represents 85 per cent of the arable land in the province and 25 per cent of the national irrigated area (Calcagno, Mendiburo, & Gaviño Novillo, 2000; FAO & PROSAP, 2015).

2. Water resources

With the melting of the high peaks in the spring and summer, water is provided by five rivers with a typical mountain system. Precipitation as rain have little input into rivers and it does occur mostly in the summertime with high intensities (Maccari, 2004).
More than 80 per cent of the water supply is employed in agriculture. In particular, the agroindustry demands nearly 13,51 hm^3 of water in order to produce processed fruits, vegetables, and beverages (Duek, Fasciolo, Quiles, & Zoia, 2013).
In terms of irrigation practices and technology adoption, the conceived policies led to the formation of two main groups. Producers with low technologic capacity consider the irrigation system a valid manner to access quality water at a reasonable cost; therefore, they welcome discussions to improve the management of the resource as long as the irrigation system remains unchanged. More traditional practices and less modern systems generally associate with higher age groups. The remaining group is conformed by market-oriented vineyards; which technology adoption does not represent a barrier neither in terms of innovation nor the investment costs (Maffioli, Ubfal, Baré, & Cerdán-Infantes, 2011).

3. General water law, principles and institutional organization

Mendoza belongs to the most arid area in Argentina, the use of water it is relevant for every economic activity. The historical relevance of water regulation is represented by the General Water Law (*Ley General de Aguas*), which was issued in 1884 prior to the provincial constitution.

Considered as a former legislation on water management, the law regulates use, distribution rules, payments and quality (DGI, 2015; Silanes, 2013). Water was declared as an asset of a public domain and three main hydric principles are represented in the water law, inherence, non-prejudice closure, and specificity.

The inherence principle determines the permanent attachment of the water right with the land property, which avoids the possibility to divide and commercialize rights individually. Additionally, the water right is perpetual unless is declined by the owner. The non-prejudice closure looks after the common welfare of water users since it considers the effects on individuals of certain actions or new activities. At last, the specificity principle ensures the nullity of contracts that use water for other purposes than the accorded (Provincia de Mendoza, 1884).

Issued in 1916, the provincial constitution rectified the formed water law and admitted the *General Irrigation Direction* (DGI, according to the name in Spanish) as the institutional body to execute the police power. This autonomous body, makes their own decisions in terms of administration, resource allocation, and investments.

Representation of stakeholders is promoted within the irrigation system. Watershed Inspections (*Inspecciones de Cauce*) are “ministry legis” by law 5302 and law 6405, their purpose is to engage in the administration and distribution of the waters, maintenance of secondary network and derivatives. Their authorities are elected democratically and they have their own budget (Maccari, 2004; Pinto, Rogero, & Andino, 2006).

4. Aspects of water management

Ideally, the organization of water management should not be static and respond to the interests of the agriculture demand along time (Jofré, 2010 p.36). Minor changes in the irrigation system directly evolve in strategic behavior and design of complimentary hydric tools. Therefore, any potential changes shall be announced in most clearly and transparent manner (Erice, 2013).

1. Current conditions of irrigation efficiency

Different definitions of efficiency belong in the water management area. In general terms, irrigation efficiency is measured as the ratio of the water volume beneficially used with respect to the received volume (Morábito, Salatino, & Schilardi, 2012). Generally, global indicator of irrigation systems measure efficiency with a combination of effectiveness ratios that qualify the water management performance. Every stage in the irrigation system is important to determine global efficiency that depends on the coating state of the channels, distribution rules, in farm use, among others.

At the northern basin, the irrigation system efficiency varies from 28 to 40 per cent. In other words, from 100 liters of water available in the system, the farmer receives between 28 and 40 liters (Bos & Chambouleyron, 1999; Jofré & Duek, 2012; Morábito et al., 2012). On average, with the methods practiced irrigation efficiency is low at the parcel level. Estimations by the DGI ranges between 30 and 50 per cent. At the provincial level, distribution efficiency is within 70 and 90 per cent, depending on the condition of the channels (Morábito, Mirábile, & Salatino, 2007; OEI-DGI, 2006).

The main causes of the low efficiency of irrigation are:

i. Reduced percentage of canal lining at the provincial level
ii. High infiltration due to the prevailing light soils and the phenomenon of clear waters;
iii. Lack of an irrigation planning to deliver water according to the actual cropping needs.
iv. Inadequate distribution systems that deliver large supply of water in a short period of time, leading to losses and waste;
v. Incomplete maintenance in major irrigation and drainage network;

In short, the technological level of irrigation at the provincial level could be markedly improved if changes in irrigation methods are introduced; scheduled rotations according to a crop plan and irrigation absent today; infrastructure improvements in irrigation and drainage, among others (FAO & PROSAP, 2015).

2. Surface and groundwater irrigation

In several regions of Mendoza, surface irrigation overlaps with groundwater irrigation. At the cost of increasing exploitation of underground resources, between 1960 and 1980, the local and national government promoted the expansion of the agriculture frontier into the arid areas (OEI-DGI, 2006). The incentives included tax exemptions and subsidized credit lines to farm technology and pumping equipment.

Table I: Comparison of irrigation systems

Aspects	Surface water	Groundwater
Physical access	Depends on the natural conditions (seasonal patterns, rainfall, etc.) but also on infrastructure	Higher infrastructure and operation costs. Less dependent on natural conditions
Abstraction costs	Fix costs normally subsidized and variable costs according to farm characteristics and management	Fix costs for use, pumping costs (variable according to the state of the source)
Distribution and equity of the public domain	Directly and visible by users. More dependency on management and co-operation	Less cooperative resource in terms of use. Difficult but desirable for co-operation
Legal access and entitlements	Managed under specific water allocation, generally with legal entitlements	Legal entitlements subject to zooning restrictions and availability
Asymmetry of information	Availability and quality easy to check and review	Regulation more difficult and costly

Source: Own elaboration based on (OECD, 2015; Theesfeld, 2010).

As stated in the Table I: above, the irrigation alternatives difference not only on the origin of the resource but on physical and institutional aspects. The conjunctive use of both resources carried in a responsible manner could derive in improvements of the groundwater quality and better use of the existing systems.

3. Groundwater quality degradation

Overexploitation of groundwater resources lead to quality degradation, which could be divided as local and diffuse pollution (Margat & van der Gun, 2013). Saline intrusion is a typical contamination effect of excessive and inefficient irrigation. This quality degradation is provoked by excessive pumping that breaks the harmony of pressure between stratums with standard percolation and infiltration levels (Kupper, Querner, Morábito, & Menenti, 2002; Morábito et al., 2005).

a) Characteristics of Carrizal aquifer

The Carrizal aquifer represents a sub-basin and is the main recharge area of the northern basin. Within this area, the development of oil and petrochemical industries have exploited the natural resources with different uses increasing pressure on the environment (Altamirano, et al., 2005).

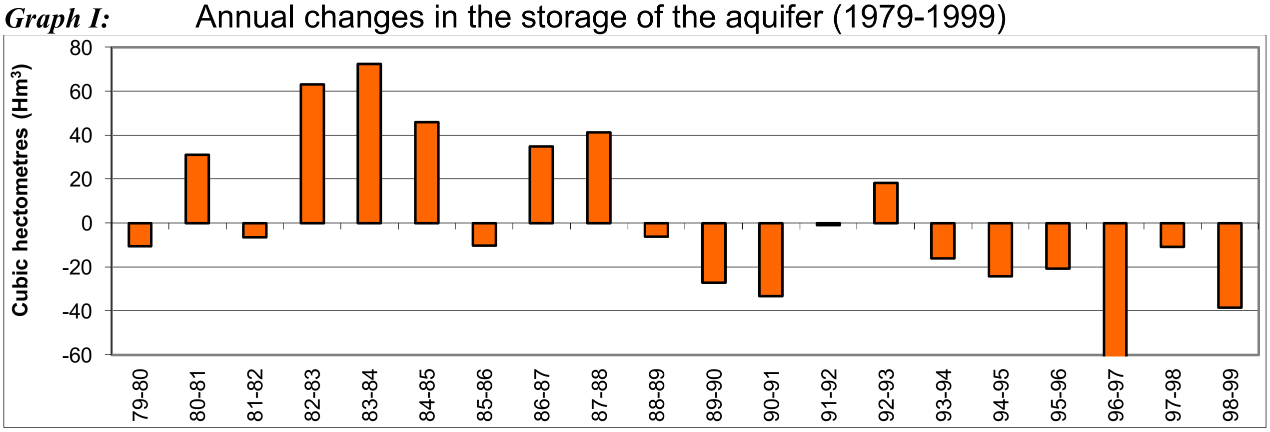
Table II: Characteristics of Northern basin and Carrizal aquifer

Northern Basin	**Area / volume**
Storage capacity	30,000 hm^3
Underground extension	22,800 km^2
Renewable resource	700 hm^3/year
Carrizal aquifer	
Groundwater abstraction	66.7 hm^3/year
Area above the aquifer	20,000 ha
Agricultural land served	5,000 ha
Grape for wine production	3,250 ha
Vegetables	1,300 ha
Olives & pastures	450 ha
Irrigation means	
Surface only	1,330 ha
Groundwater only	1,330 ha
Conjoint use	1,330 ha

Source: Own based on (Foster & Garduño, 2005; Hernández et al., 2012; IDR, 2016; OEI-DGI, 2006).

After the construction of the Potrerillos Dam during early 2000s, the hydrology of the northern basin has changed. Due to the fact that the river carries less sediments, carried water is lighter and easier to filtrate on the ground; this phenomenon is known as clear waters. Until 1999, an accurate estimation of the groundwater abstraction in the Carrizal aquifer is 66.7 hm^3 per year (Hernández, et al., 2013).

Graph I: Annual changes in the storage of the aquifer (1979-1999)



Source: Hernández et al. (2013).

According to Hernández, et al., (2013), the average pumped water in the Carrizal aquifer was 61,235 cubic hectometer (hm^3) between 1979 and 1999. Due to the increasing public concern on groundwater pollution and delivery of illegal permits for groundwater wells in the past (Conte, 2014; Erice, 2013; Fernández Rojas, 2012), the information about storage of the aquifer is classified at the moment.

B. Conceptual and analytical framework

Groundwater is a common-pool resource subtractability and low-excludability (OECD, 2015). The solely existence of underground resources raises concerns about their characteristics: boundaries of the reserve, the hydrogeological uncertainties, irreversibility of mismanagement, and information asymmetries (Booker, Howitt, Michelsen, & Young, 2012; NRC, 1997; Theesfeld, 2010).

The institutional tripod is a framework to decouple the roles of organizations and stakeholders at different levels. It helps to understand the underlining power structures, decision making stages and incentives of participants in the political process.

Meinzen-Dick introduced the framework acknowledging that "*there is no single solution for all water problems*" in policy analysis (2007, p. 15205). An objective manner for analysis is decomposing the policy instruments in regulatory, economic, and voluntary. The regulatory instruments frame the command and control of water policies. That is the ownership of rights, standards for pollution, abstraction, among others. In most of cases, water rights are attached to the agriculture land and are non-tradable.

Table III: Current policy tools on water management

<table>
<tr><th colspan="2">Instrument / Orientation</th><th>Regulatory approaches</th><th>Economic instruments</th><th>Collective management approaches</th></tr>
<tr><td rowspan="3">Demand side approaches</td><td>Extensive margin (wells)</td><td>Permit requirement</td><td></td><td>Association of groundwater users</td></tr>
<tr><td rowspan="2">Intensive margin (use)</td><td>Direct: Flowmeter</td><td>Direct: Higher annual fee
Energy subsidies</td><td></td></tr>
<tr><td>Indirect: empowerment of water institutions</td><td>Indirect: assistance to improve infrastructure</td><td>Indirect: determination of turn scheme</td></tr>
<tr><td rowspan="2">Supply side approaches</td><td>Additional supply for storing</td><td></td><td></td><td>Construction of reservoirs</td></tr>
<tr><td>Additional supply for use</td><td>Surface water supply: Turn scheme</td><td>Financing infrastructure</td><td>Collective management plans</td></tr>
</table>

Source: Own based on DGI (2008); Erice (2013); OECD (2015); Theesfeld, Schleyer, & Aznar (2010).

OECD (2015) and Theesfeld et al. (2010) coincide on analyzing institutions involved, power structures, and independence of decision makers to comprehend the political process of water policy. Regarding the economic instruments, they reflect the financial incentives that may drive the decision of the stakeholders; this could be directly influenced by groundwater fees related to infrastructure, location and services (Zilberman, et al., 2008).

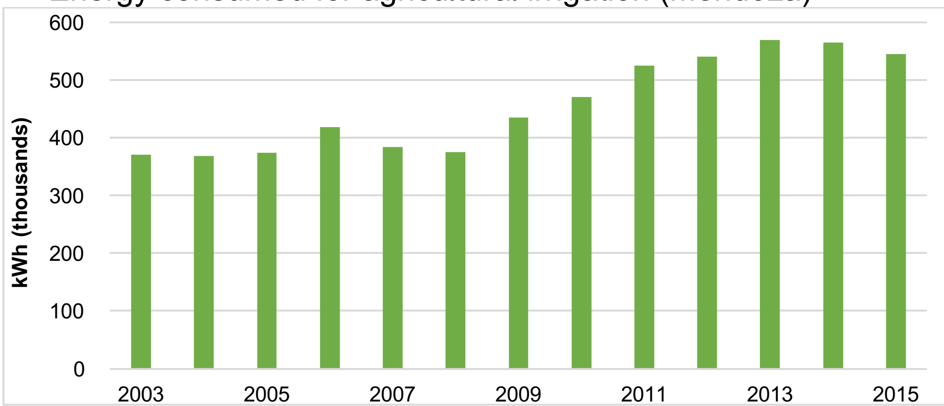
Furthermore, the joint analysis of physical conditions and institutional settings that consider asymmetric information are critical factors for design and implementation of policies (Dinar, 2000). To achieve a comprehensive governance structure on public

institutions, a systematic review of planning and policy instruments is essential (Theesfeld, 2010).
Energy policies that subsidize groundwater withdrawals are commonly referred as ill-conceived policies (Bailis, 2011). Since the marginal cost of acquiring water for irrigation decreases, it is possible that economic agents continue or start employing water inefficiently.
It is expected that lowering energy subsidies for agricultural irrigation will correct the economic incentives to diminish groundwater use. What is still unknown is a good estimate of the demand function of groundwater for agriculture in the area of study. Regarding other areas in the northern basin in Mendoza, the price elasticity is 0.57 per cent for producers that only use groundwater and 1.28 for users with access to both types of irrigation systems (Barbazza, 2005).
Other studies in India analyze the effect of 10 per cent reduction on energy subsidies and obtained a decrement of the pumped water between 4.4 and 6.7 per cent (Badiani & Jessoe, 2011; OECD, 2015; Shah et al., 2012). While in the case of Mexico, Sun, Sesmero, & Schoengold, (2016) consider that doubling the cost of pumping would only reduce demand by 6 per cent. However, the total withdraw of energy subsidy will decrease 15 per cent the pumping in the short run and settle in 19 per cent in the long term (OECD, 2015).
Often, energy subsidies for irrigation efficiency are interpreted as a double-edged sword in groundwater management (OECD, 2015). Acquiring higher efficiency standards on irrigation is more beneficial for farmers but could deteriorate soil quality or aquifer recharge. Some additional measures should foster cultivation of less water demanding crops to avoid negative effects of the measure.
Coady, et al. (2015) consider that efficient pricing from energy producers to suppliers shall equal the cost of production. Additionally, pigouvian taxation is a tool to correct externalities that are not covered by other political measure. Moreover, Sun, Sesmero, & Schoengold (2016) have shown that effectiveness of electricity price based policies are certainly arguable for groundwater as a common pool resource.

1. Energy and subsidy information

In Mendoza, the energy production increased at lower rates than the total demand. The province of does not perform satisfactory on energy self-sufficiency. Imported energy in total consumption is nearly 20 per cent (EPRE, 2013).
Since 2011, the province is under water scarcity, which means that the snowfalls during winter have not fulfilled the expected demand of water for irrigation for spring and summer season. Fewer surface water supply translates into more energy demanded for pumping groundwater.

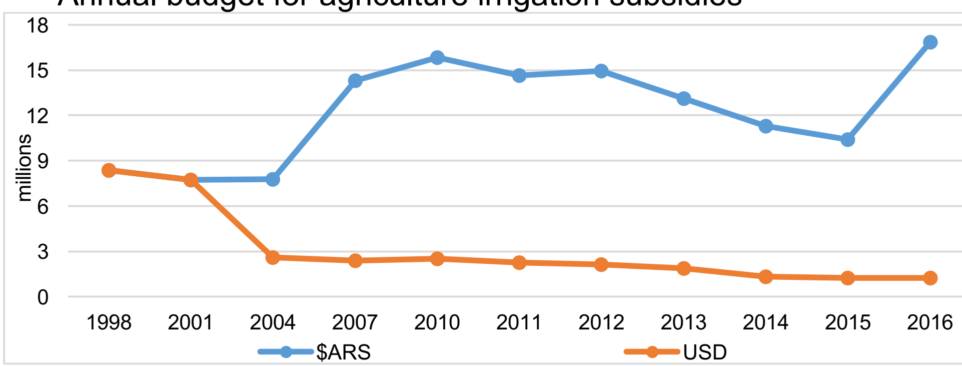
Graph II: Energy consumed for agricultural irrigation (Mendoza)



Source: Own based on DEIE (2014); EPRE (2013, 2016).

The graph above shows an increasing demand on energy from year 2009 onwards. Currently, the annual consumption of subsidized energy for agricultural irrigation is 45 per cent higher than last decade with an increased 10,7 per cent share in the total energy demanded (DEIE, 2014; EPRE, 2015).

Graph III: Annual budget for agriculture irrigation subsidies



Source: Own based on DEIE, (2014); Gobierno de Mendoza, (2010).

In terms of government budget, the expenditure for energy subsidies applied on agricultural irrigation increased in nominal terms (Argentinean peso) but decreased in real terms (US Dollar). Although, the new administration assumed a devaluation of the local currency near 40 per cent at the end of 2015; the budget for this purpose increased in local currency.

2. Composition of energy prices

Promoting agriculture irrigation by subsidizing energy prices is a policy tool that seek to leverage small agriculture producers who are non-capable of improving their production efficiency due to their scale or subsequent year of economic loses. The subsidy is achievable upon request and is not targeting any group of consumers. Only those properties smaller than 50 ha can avoid a tariff increase from year 2008. Exceptionally, farmers that do not receive surface water may qualify as well.

Since the subsidy is attached to a property (agricultural parcel) and not to a specific person, strategic behavior by stakeholders could lower the efficiency of the energy policy. Regulated by the law 6,498, the irrigation tariff establishes a compensation from the provincial state to the energy distributors. Moreover, the law determines tariff segments according to the time slot that energy is consumed (EPRE, 2016). The time slot for high-demand has changed continuously, establishing one or two time-slots of higher pricing during the day. In fact, these changes seek to segment the demand for targeted pricing. However, as pointed by Severino (2005), these time slots do not correlate with the national energy market that provide local distributors.

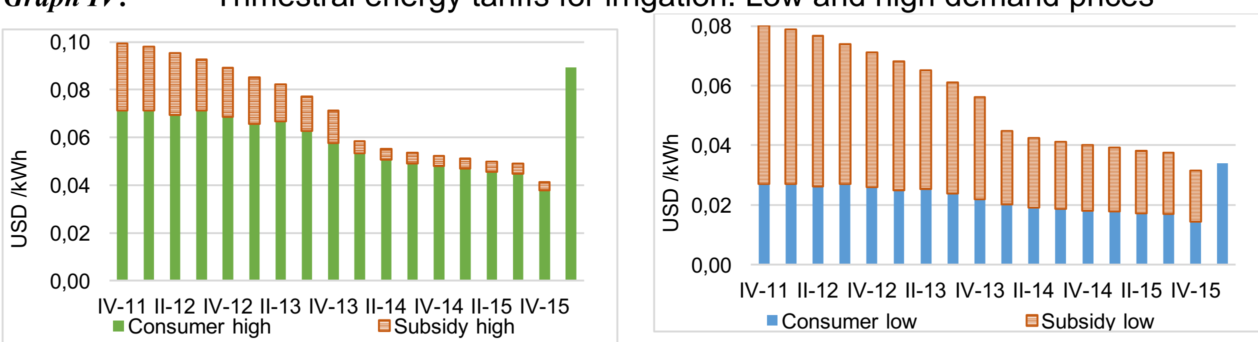
Table IV: Subsidy scheme including fix costs of energy provision (2012)

Pumping equipment power	Lower voltage		Medium voltage	
	High-demand	Low-demand	High-demand	Low-demand
< 10 Kw	57,4%	79,0%	63,2%	79,0%
10 < Kw < 300	57,3%	79,0%	63,1%	79,0%
> 300 Kw	50,5%	69,6%	55,6%	69,6%

Source: Own based on EPRE, (2016).

On a yearly basis, the provincial energy regulator (EPRE) seek to improve policy targeting by visiting beneficiaries randomly and checking their subsidy qualification. This action has contributed to improve the policy targeting by decreasing the list of beneficiaries by 10 per cent. Normally, the subsidized power for agriculture irrigation is near 4 megawatt hour (MWh) per year, from which 20 per cent is estimated as inefficiency loss due to improper pumping equipment (Severino, 2016).

Graph IV: Trimestral energy tariffs for irrigation. Low and high demand prices



Source: Own based on DEIE (2014), EPRE (2016).

The new government administration announced increments in the energy tariffs by 150 per cent. Although the agriculture beneficiaries will continue to receive the subsidy; the total amount of subsidy budget shall also increase. Attempts to withdraw the energy subsidies for agricultural irrigation have not been successful in the past.

C. Water policy and political economy of water resources in Mendoza

Although there is an agreement on quality monitoring across water institutions, levels of salinization of and resource depletion have increased along time on the aquifer (Conte, 2014; Foster & Garduño, 2005; OEI-DGI, 2006). Water quality is affected by industrial activity and agriculture practices; in particular cadmium (Morábito et al., 2005) and phosphorus levels (Lavie, et al., 2010).

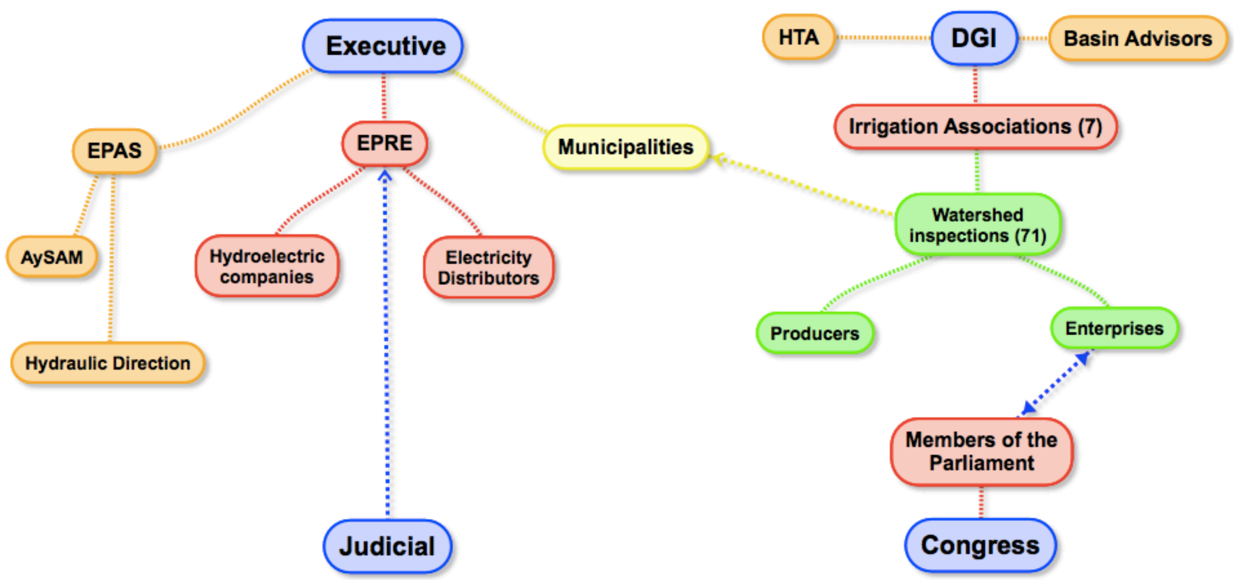
In the past, the water bodies have created conditions for improving the resource management and diminish pollution in a long term perspective (Jofré & Duek, 2012). However, to approach earlier results, stakeholders shall be stimulated to perform

collective action in resource exploitation through economic tools that internalize trade-off decision between productivity and environmental effects (Ostrom, 1990, 2014).
As shown in the previous Table V:, the participation and disputes related to water-energy policies have a rich content. Several external effects drive the excessive pumping of groundwater, the water scarcity period since 2011 implied lower volume of surface water to deal with higher temperatures and uncertain rainfall. Regarding the economic sphere, low profitability bailed the incentives for improve irrigation efficiency at the parcel level.
In other terms, the reform arena was not suitable for the relaxation of subsidy scheme. Both situations are jointly responsible for the diminishing water-table levels in the aquifer and increments in the depth of water extracted (Alvarez & Fasciolo, 2011; Foster & Garduño, 2005; Puebla et al., 2005).
Undoubtedly, the policy planning has been undermined by several economic and environmental facts during the last 15 years. The review of the political treatment of pollution accusations and the attempts to modify the agricultural irrigation subsidies have reveal the weaknesses of decision makers. The slight possibility of modifying the *status quo* of acquired subsidies for water abstraction implies a quick response from lobbyist and watershed inspections that feel their power space wounded.

D. Discussion & Conclusions

During 2013, the energy destined to agriculture irrigation was nearly 600,000 kWh. That is 10.72% of the total energy consumption in the province. From the 300 MW of installed energy capacity for agricultural irrigation, the Ministry of Energy estimates that 15 per cent are inefficiently used. This represents USD 14,6 million of government expenditure (EPRE, 2015).

Graph V: Characterization of institutions



Source: Own based on (DGI, 2015; Maccari, 2004; OEI-DGI, 2006; Severino, 2005).

Considering the scope of this document, the beneficiaries of the irrigation policies are the agriculture producers. Findings indicate joint implications of water and energy policies for groundwater availability. The DGI remains as the highest authority in terms of resource administration, information systems and control of the water system. The resulting analysis in table III deploys of more policy tools oriented to the demand side and relevant participation of collective management within the framework.

Conceiving a subsidy to extract water may improve the living standard of less profitable farmers is not the right orientation to improve their livelihood. On the contrary, when policies are not complemented under instructive and participatory approaches that improve water management; farmers will continue to rely on their traditional irrigation practices with a marginal productivity of water constant and similar cost of production.

Jointly, the review of the institutional settings and the political disputes about water resources quality and management reveal the public sensibility on the pollution of common pool resource, as the Carrizal aquifer. In particular, when quality degradation is not diffuse but local.

In order to gain political credibility, public institutions need to show the risks, benefits and expose responsibility to deal with groundwater issues (Foster & Garduño, 2012). A credible threat of loosing rights could create enough incentives to improve groundwater management (Livingston & Garrido, 2004).

As stated by Abler & Shortle (1991), the political changes will be viable if effects positively on the institution’s budget, gain confidence from large stake political space, and optimize the administrative and enforcement costs. Although, it is expected that lowering energy subsidies for agricultural irrigation will correct the economic incentives to diminish groundwater use; in the past no clear and consistent policies were taken to improve the targeting of beneficiaries of more towards full-pricing energy tariffs.

In these conditions, the stakeholders may perceive that no changes in policies and incentives to continue their business as usual. If the recent modification of electricity tariffs imposed by the national government comes along with better targeting of subsidy beneficiaries, the marginal cost of water abstraction would increase maybe improving irrigation practices and diminishing the overexploitation of the aquifer.

E. Annex

Table V: Record of political disputes in the last 15 years

Year	Detail	Source
1998	Zooning restriction by DGI for new groundwater wells at the Carrizal aquifer.	Erice, (2013); Foster & Garduño (2006)
2002	EPRE requires more detail on energy bills	DGI (Res. 437/02)
2003	Public dispute about salinization pollution in the Carrizal aquifer. The privatized oil refinery is accused by the stakeholders to contaminate the underground resource	Oikos (2004); Reta (2005)
	Judge suspend YPF to use a groundwater well until environmental conditions are reviewed	
2004	Luján de Cuyo municipality request YPF to avoid the use of groundwater as blowdown water in oil production	Conte (2014); Erice (2013); Garduño & Foster (2010); Lohn, et al. (2000); Oikos (2004); Severino (2005)
	Pollution by salinization is detected at the Carrizal aquifer by the National Institute of Water (INA).	
	Conflict between agriculture producers and YPF is mediated by the government that confirms no polluting activities by YPF.	
	Ministry of Environment and Public Works (MAyOP) issues a decree to review the voltage supply capacity and adopt new segmentation criteria based on user's pumping equipment voltage.	
	Government estimates saving for 2.4% of energy for agriculture irrigation from high tension users. Express their interest to resign for subsidy in 2005 onwards.	
	Agricultural lobbyist from central valley stop a new attempt to increase agricultural irrigation energy tariffs. They requested to remain the energy subsidy for irrigation and abolish the temporal sessions of water rights	
	Province executive sanctions decree to increase electricity tariffs by at least 25 per cent. Decree (1456/04)	
	Strong public opposition against potential tariffs increase	
2007	Provincial government creates a Council to review the environmental conditions of Carrizal aquifer in the districts of Ugarteche and El Carrizal.	Erice (2013) *Decree (1684/07)*
	Provincial law 7,722 limits the chemical components as cyanide, mercury and sulphuric acid in the exploitation of natural resources. Therefore, the use of water is protected towards mining activities.	Soria, (2015)
2009	YPF lose a judicial dispute for groundwater pollution and must reimburse an individual family for $ARS 675,000	Fernández Rojas (2012)
2010	According to INA, the water table levels of the Carrizal aquifer show signs of recovery and it could resist up to 5 per cent year increase in water pumping. The DGI withdraws the zooning restriction for new wells and accept 22 request without following proper steps. DGI superintendent is criticized and resigns avoiding impeachment in 2013.	DGI (2008); Erice (2013)
2011	EPRE modifies the tariffs' segmentation scheme to lower the voltage demand peaks	*Decree (208/2011)*
2014	DGI allows YPF to perform oil exploration in a new groundwater well in a conflict area for pollution with out confirming reception of the impact evaluation declaration	Montacuto, (2014)
2015	The Court of Supreme Justice ratifies the constitutionality of the law 7,722	Soria (2015)
2016	YPF announces three new wells for oil exploitation in the province	Flores Isuani, (2016)

Source: Author.

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